CLAIMS

What is claimed is:

1. A droplet ejection apparatus comprising:

a plurality of droplet ejection heads, each of the droplet ejection heads including:

a diaphragm;

an actuator which displaces the diaphragm;

a cavity filled with a liquid, an internal pressure of the cavity being increased and decreased in response to displacement of the diaphragm; and

a nozzle communicated with the cavity through which the liquid is ejected in the form of droplets in response to the increase and decrease of the internal pressure of the cavity;

a driving circuit which drives the actuator of each droplet ejection head;

oscillation means which generates a signal on the basis of a residual vibration of the diaphragm displaced by the actuator after driving the actuator by the driving circuit;

subtracting means which subtracts the number of pulses, which are included in the signal generated by the oscillation means for a predetermined time period, from a predetermined reference value; and

judging means for judging whether or not an ejection failure is occurring in the droplet ejection heads on the basis of the subtraction result by the subtracting means.

2. The droplet ejection apparatus as claimed in claim 1, wherein the judging means judges a cause of the ejection failure when it is judged that the ejection failure is occurring.

3. The droplet ejection apparatus as claimed in claim 1, wherein the judging means judges that an air bubble has intruded into the cavity in the case where the subtraction result is

smaller than a first threshold.

4. The droplet ejection apparatus as claimed in claim 1, wherein the judging means judges that the liquid in the vicinity of the nozzle has thickened due to drying in the case where the subtraction result is larger than a second threshold.

5. The droplet ejection apparatus as claimed in claim 4, wherein the judging means judges that paper dust is adhering in the vicinity of the outlet of the nozzle in the case where the subtraction result is smaller than the second threshold and larger than a third threshold.

6. The droplet ejection apparatus as claimed in claim 2, further comprising storage means for storing the cause of the ejection failure judged by the judging means.

7. The droplet ejection apparatus as claimed in claim 1, further comprising switching means for switching a connection of the actuator from the driving circuit to the oscillation means after carrying out a droplet ejection operation by driving the actuator.

8. The droplet ejection apparatus as claimed in claim 1, wherein the oscillation means includes a resistance component connected to the actuator, and forms a CR oscillation circuit based on the electric capacitance component of the actuator and a resistance component of the resistor element.

9. The droplet ejection apparatus as claimed in claim 1, wherein the predetermined time period includes one or more time period in the residual vibration of the diaphragm when the droplet is normally ejected from the droplet ejection head.

10. The droplet ejection apparatus as claimed in claim 9, wherein the predetermined time period is a time period until

the residual vibration is generated after the droplet has been normally ejected from the droplet ejection head.

11. The droplet ejection apparatus as claimed in claim 9, wherein the predetermined time period is a time period until a half cycle of the residual vibration of the diaphragm after the droplet has been normally ejected from the droplet ejection head.

12. The droplet ejection apparatus as claimed in claim 9, wherein the predetermined time period includes time periods of every half cycle of the residual vibration of the diaphragm after the droplet has been normally ejected from the droplet ejection head.

13. The droplet ejection apparatus as claimed in claim 9, wherein the predetermined time period is a time period until a quarter cycle of the residual vibration of the diaphragm after the droplet has been normally ejected from the droplet ejection head.

14. The droplet ejection apparatus as claimed in claim 9, wherein the predetermined time period includes time periods of every quarter cycle of the residual vibration of the diaphragm after the droplet has been normally ejected from the droplet ejection head.

15. The droplet ejection apparatus as claimed in claim 1, wherein the predetermined reference value is the number of pulses in the signal generated by the oscillation means for the predetermined time period when the droplet is normally ejected from the droplet ejection head.

16. The droplet ejection apparatus as claimed in claim 1, wherein the judging means judges whether or not an ejection failure is occurring in the respective droplet ejection heads

on the basis of the subtraction result obtained by the subtracting means when the oscillation means generates the signal by scanning each of the plurality of droplet ejection heads.

17. The droplet ejection apparatus as claimed in claim 1, wherein the actuator includes an electrostatic actuator.

18. The droplet ejection apparatus as claimed in claim 1, wherein the actuator includes a piezoelectric actuator having a piezoelectric element and using a piezoelectric effect of the piezoelectric element.

19. The droplet ejection apparatus as claimed in claim 1, wherein the droplet ejection apparatus includes an ink jet printer.

20. A method of judging an ejection failure of droplet ejection heads, each droplet ejection head including a diaphragm, an actuator, a cavity and a nozzle, the method comprising the steps of:

generating a signal with an oscillation circuit on basis of a residual vibration of the diaphragm after carrying out an operation in which a liquid within the cavity is ejected through the nozzle in the form of droplets by driving the actuator with a driving circuit and thereby displacing the diaphragm;

subtracting the number of pulses, of which the signal generated by oscillation means is generated for a predetermined time period, from a predetermined reference value; and

judging whether or not an ejection failure is occurring in the droplet ejection heads on the basis of the subtraction result.

21. The method as claimed in claim 20, further comprising the step of:

judging a cause of the ejection failure when it is judged

that the ejection failure is occurring.

22. The method as claimed in claim 21, wherein the cause judging step includes the steps of:

judging that an air bubble has intruded into the cavity in the case where the subtraction result is smaller than a first threshold;

judging that the liquid in the vicinity of the nozzle has thickened due to drying in the case where the subtraction result is larger than a second threshold; and

judging that paper dust is adhering in the vicinity of the outlet of the nozzle in the case where the subtraction result is smaller than the second threshold and larger than a third threshold.

23. The method as claimed in claim 21, further comprising the step of:

storing the judgment result in a storage section.

24. The method as claimed in claim 20, further comprising the step of:

switching a connection of the actuator from the driving circuit to the oscillation circuit after carrying out a droplet ejection operation by driving the actuator.

25. The method as claimed in claim 20, wherein the predetermined time period is one or more time period in the residual vibration of the diaphragm when the droplet is normally ejected from the droplet ejection head, which includes: a time period until the residual vibration is generated after the droplet has been normally ejected from the droplet ejection head; a time period until a half cycle of the residual vibration of the diaphragm after the droplet has been normally ejected from the droplet ejection head; time periods of every half cycle of the residual vibration of the diaphragm after the droplet has been normally ejected from the droplet ejection head; a time

period until a quarter cycle of the residual vibration of the diaphragm after the droplet has been normally ejected from the droplet ejection head; and time periods of every quarter cycle of the residual vibration of the diaphragm after the droplet has been normally ejected from the droplet ejection head.

26. The method as claimed in claim 20, wherein the predetermined reference value is the number of pulses, which are included in the generated signal for the predetermined time period when the droplet is normally ejected from the droplet ejection head.